

Visual Growth - An Integrated Suite of Reliability Growth Programs

68th MORS Symposium

Presenter: William J.
Brymen
2000



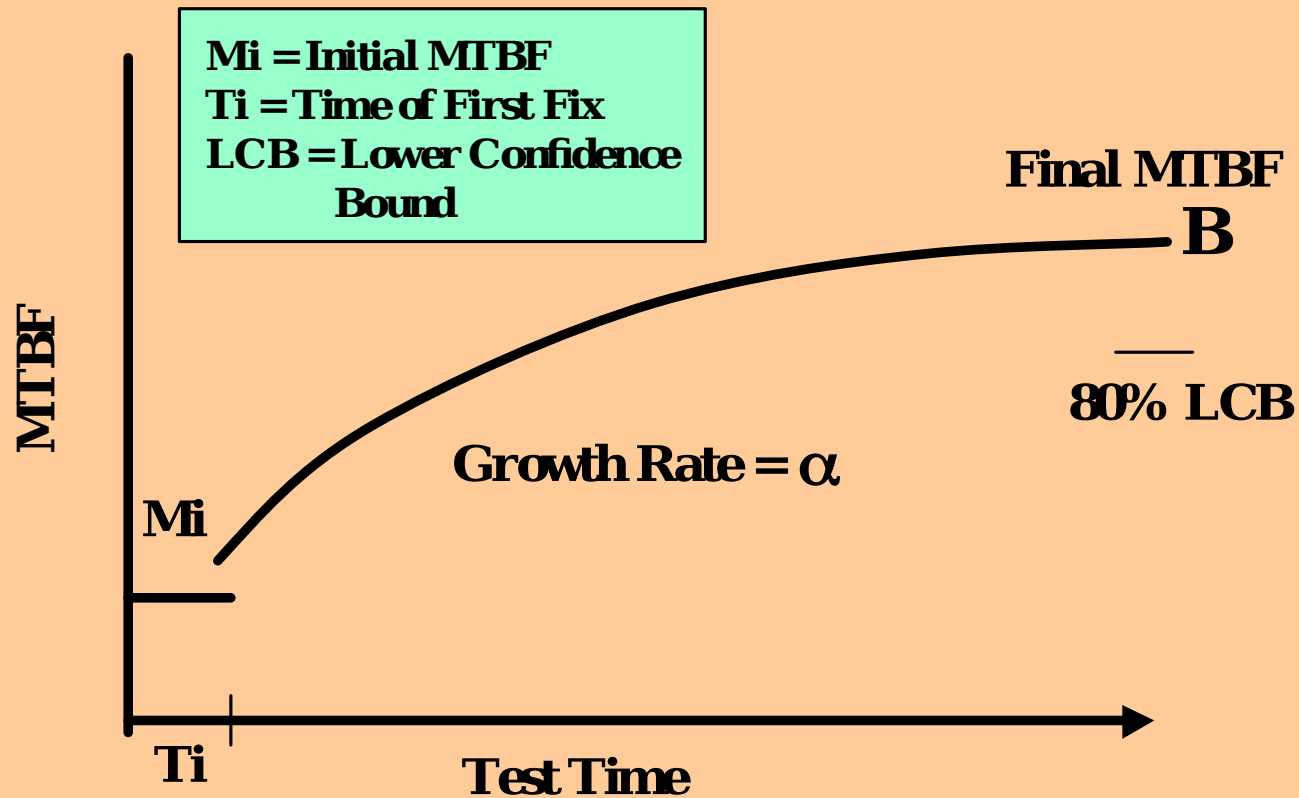
U.S. Army Materiel Systems Analysis Activity
Aberdeen Proving Ground, Maryland



Background

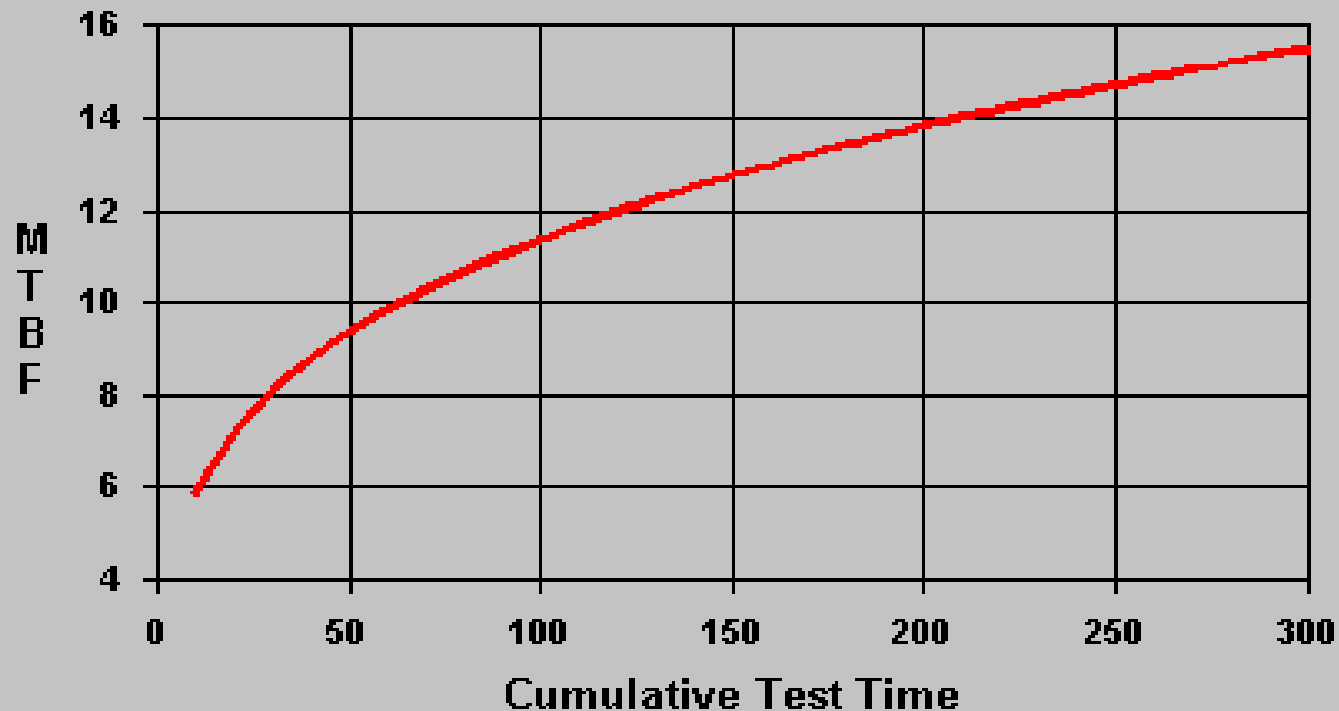
- Reliability Growth: the improvement in a reliability parameter over a period of time due to changes in the product design or manufacturing process.
- AMSAA reliability growth model is probabilistic/management tool for:
 - Planning: Optimize testing and resources. Provide strategy to reduce risk.
 - Tracking: Ensure requirements are met in Reliability Demonstration Test.
 - Projection: Assess reliability at future milestones based on planned and implemented fixes to surfaced failure modes.

RELIABILITY GROWTH CURVE



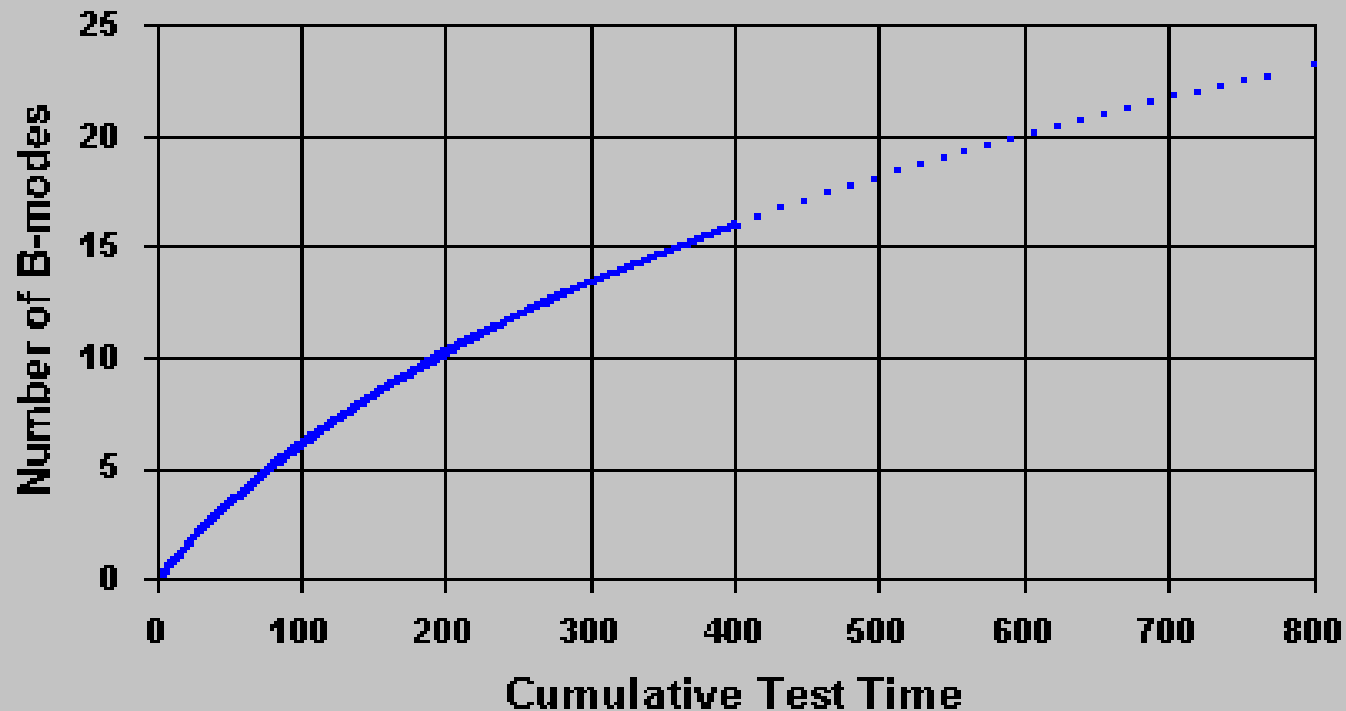
Planning Model used to quantify potential risk elements.

**AMSAA Reliability Growth Tracking Model - Continuous
Individual Failure Times - MTBF growth curve**



Tracking Model used to estimate current demonstrated reliability

AMSAA Maturity Projection Model Projected Expected Number of B-modes



Projection Model used to estimate reliability at future milestones

List of Reliability Growth Programs

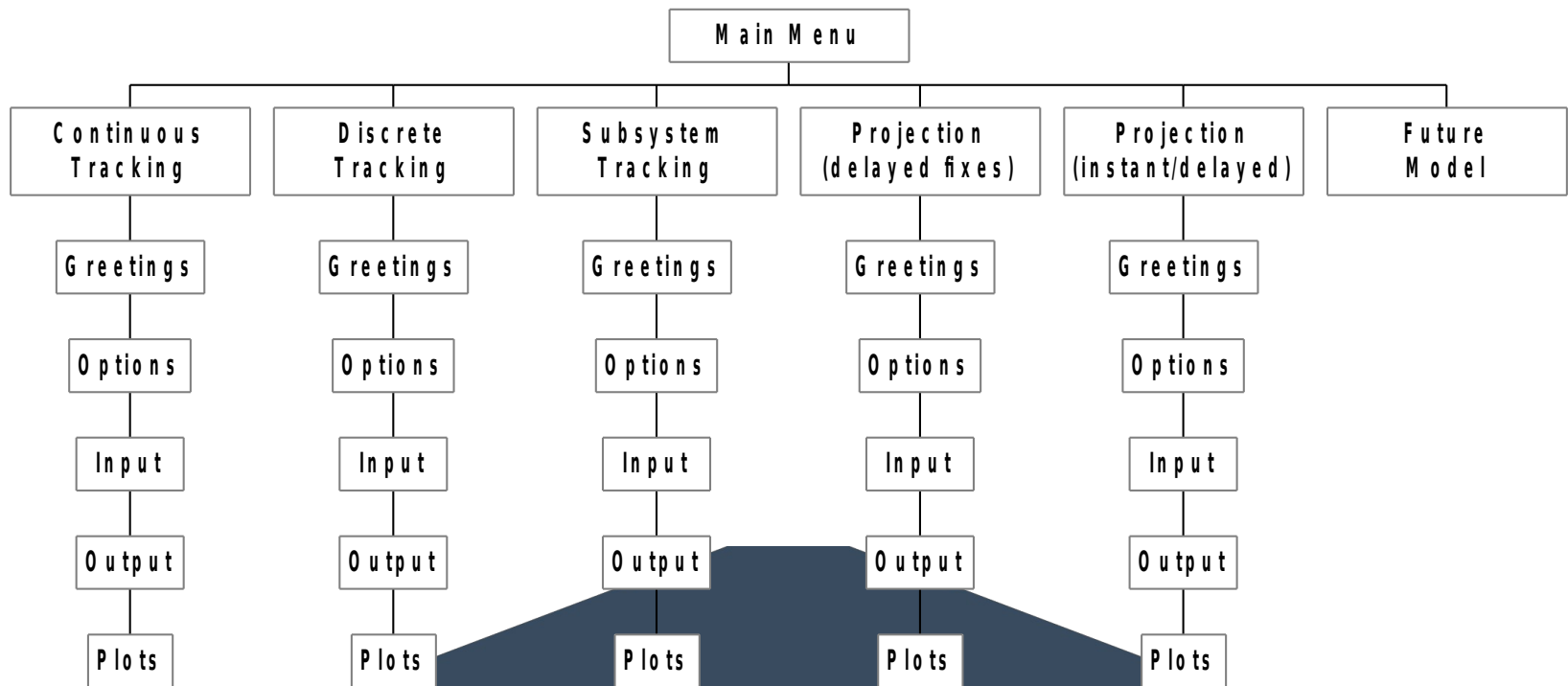
- 1 Planning - System Level - Continuous
- 2 Planning - Subsystem Level - Continuous
- 3 Tracking - System Level - Continuous
- 4 Tracking - System Level - Discrete
- 5 Tracking - Subsystem Level - Continuous
- 6 Projection - System Level - Continuous - Delayed Fixes
- 7 Projection - System Level - Continuous - Instantaneous or Delayed Fixes
- 8 Projection - System Level - Discrete

Taxonomy of Reliability Growth Models

Level Phase	<u>System</u>	<u>Subsystem</u>
<u>Planning</u>	Continuous	Continuous
<u>Tracking</u>	Continuous * Discrete *	Continuous *
<u>Projection</u>	Cont. Delayed Fixes * Cont. Instant/Delayed Fixes * Discrete	

* member of the Visual Growth suite

Structure of Visual Growth



Common Framework Across All Reliability Growth Programs

Splash Screen

U.S. Army Materiel Systems Analysis Activity
Acquisition and Technology Support Division
Reliability Methodology Team

Visual Growth

Beta Version 1.3



Exit

Next >

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Main menu

Visual Growth (0) [Main menu]

File Help

Choose a model option or click the Stop button

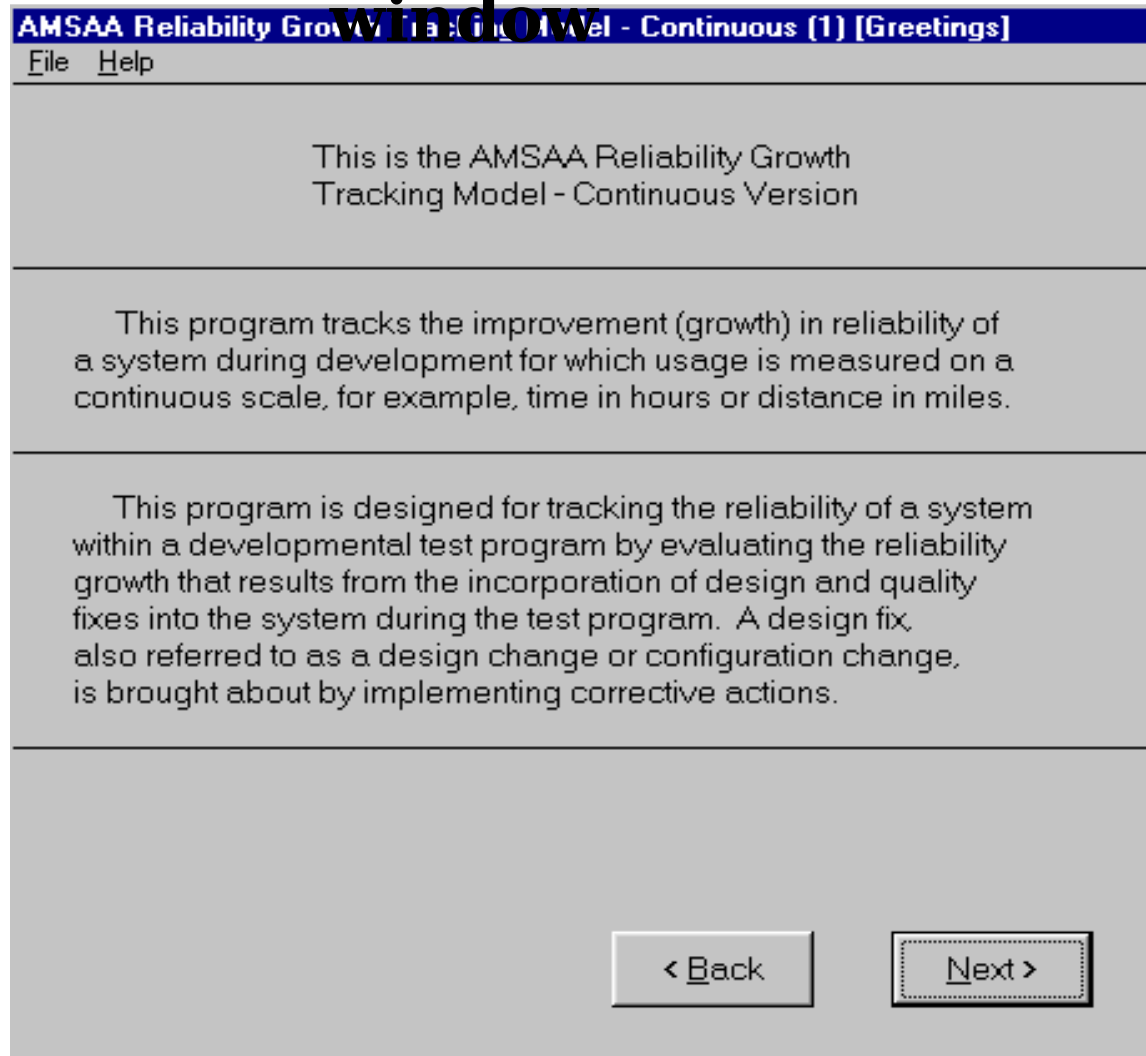
- ☐ System Planning Model (SPLAN)
- ☐ Reliability Growth Tracking Model - Continuous (RGTMC)
- ☐ Reliability Growth Tracking Model - Discrete (RGTMD)
- ☐ Subsystem Level Tracking Model (SSTRACK)
- ☐ AMSAA-Crow Projection Model (ACPM)
- ☐ AMSAA Maturity Projection Model (AMPM)

Select a model or click the Stop button.

Stop!

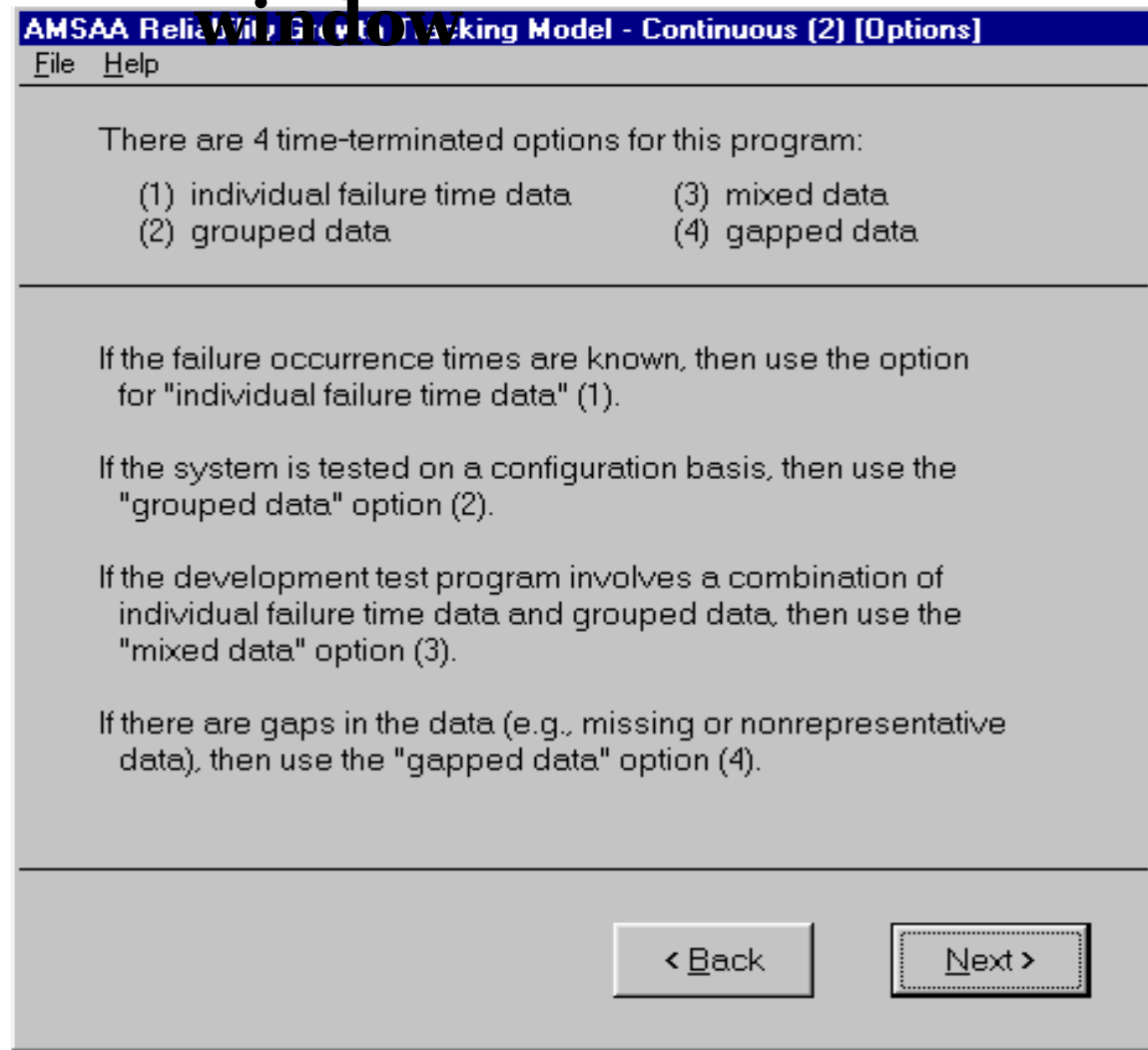
Greetings

window



Options description

window



Options selection

AMSAA Reliability Growth Testing Model - Continuous (3) [Options]

Choose an option

- ☐ Individual Failure Time Data
- ☐ Grouped Data
- ☐ Mixed Data
- ☐ Gapped Data
- ☐ Return to the previous window

< Back

Input

window

Tracking - Continuous - Individual Failure Time Data (4) [Input]

This is the option for individual failure time data.

The required data consist of the:

- total test time
- total number of failures
- individual failure times

Click here to see how to construct a data file of failure times

[Data File](#)

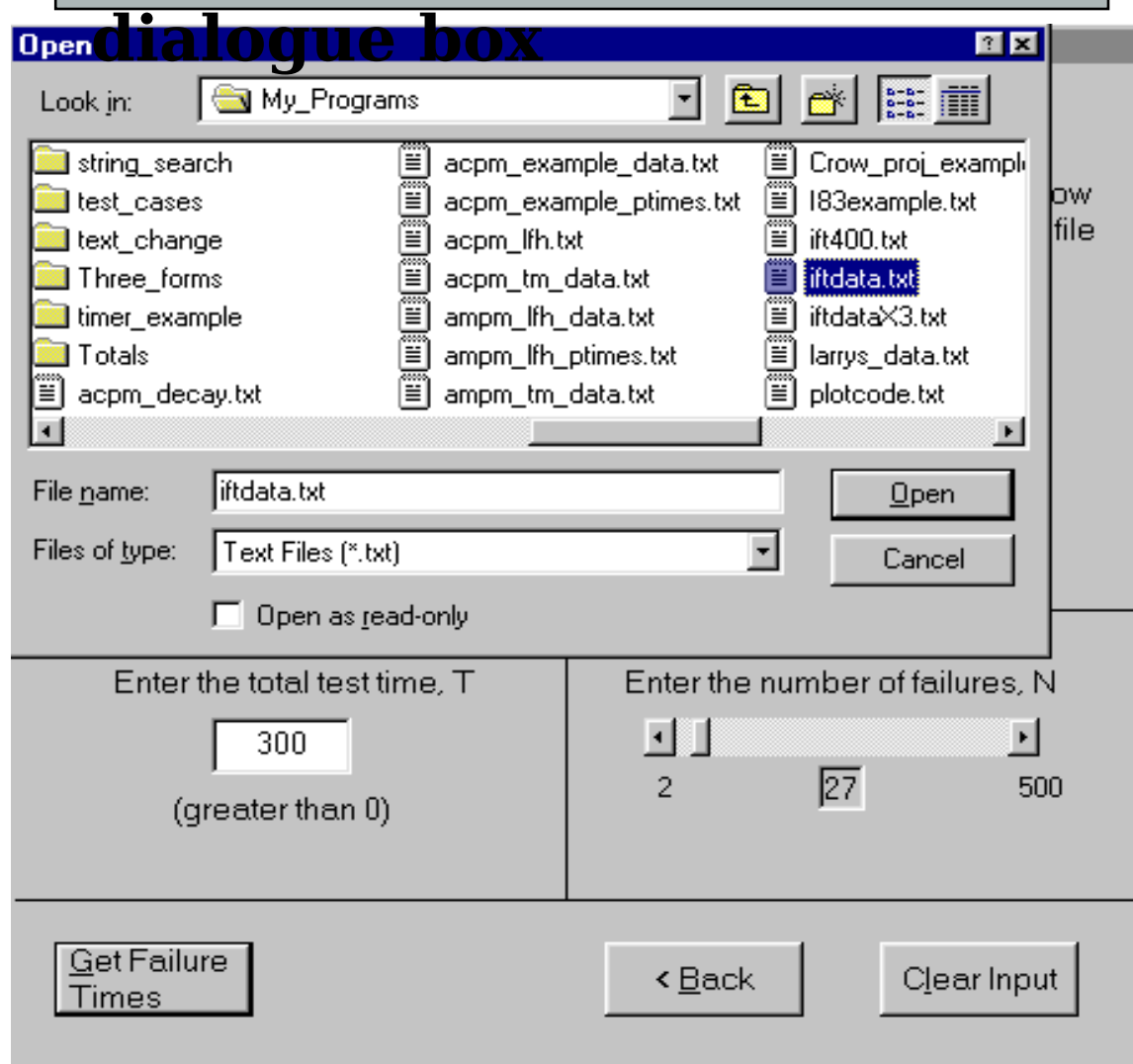
Note that this option:

- is for 1 time line only
- assumes that the starting test time is 0
- is to be used for time terminated testing only

Enter the total test time, T <input type="text" value="300"/> (greater than 0)	Enter the number of failures, N <input type="text" value="27"/> 2 500
--	---

Get Failure Times	< Back	Clear Input
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Input window w/ Open



Input

window

Tracking - Continuous - Individual Failure Time Data (4) [Input]

This is the option for individual failure time data.

The required data consist of the:

- total test time
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[Data File](#)

Note that this option:

- is for 1 time line only
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<p>Enter the total test time, T</p> <p><input type="text" value="300"/></p> <p>(greater than 0)</p>	<p>Enter the number of failures, N</p> <p><input type="text" value="27"/> <input type="text" value="500"/></p> <p>2</p>
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[Compute](#) [< Back](#) [Clear Input](#)

Model

results

AMSAA Reliability Growth Tracking Model - Continuous (5) [Output]

AMSAA Reliability Growth Tracking Model - Continuous
Individual Failure Time Data

Model results for individual failure time data.

Total amount of test time (T)	300.00
Total number of failures (N)	27
Scale parameter estimate (lambda)	.453842
Growth parameter estimate (beta)	.716
Unbiased estimate of growth parameter	.690
Growth rate estimate (alpha)	.284
Failure intensity estimate at time T	.064471
MTBF estimate at time T	15.5

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Goodness-of-Fit

results

AMSAA Reliability Growth Tracking Model - Continuous (6) [Output]

AMSAA Reliability Growth Tracking Model - Continuous
Individual Failure Time Data

Goodness of Fit Results

Total number of failures 27
Cramer-von Mises statistic .091

Table of Critical Values
for Cramer-von Mises Goodness of Fit Test

Number of Failures	.20	.15	.10	.05	.01
20	.128	.146	.172	.217	.330
30	.128	.146	.172	.218	.330

If Cramer-von Mises statistic is greater than critical value
at desired level of significance, then REJECT model.

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Table of LCBs

AMSAA Reliability Growth Tracking Model - Continuous (7) [Output]

AMSAA Reliability Growth Tracking Model - Continuous
Individual Failure Time Data

Table of Lower Confidence Bounds (LCBs)
for the True MTBF at end of Reliability Growth Test

Confidence Level (Percent)	LCB	Confidence Level (Percent)	LCB
50	15.14	80	12.11
55	14.63	85	11.52
60	14.14	90	10.82
65	13.66	95	9.87
70	13.16	98	8.91
75	12.65	99	8.34

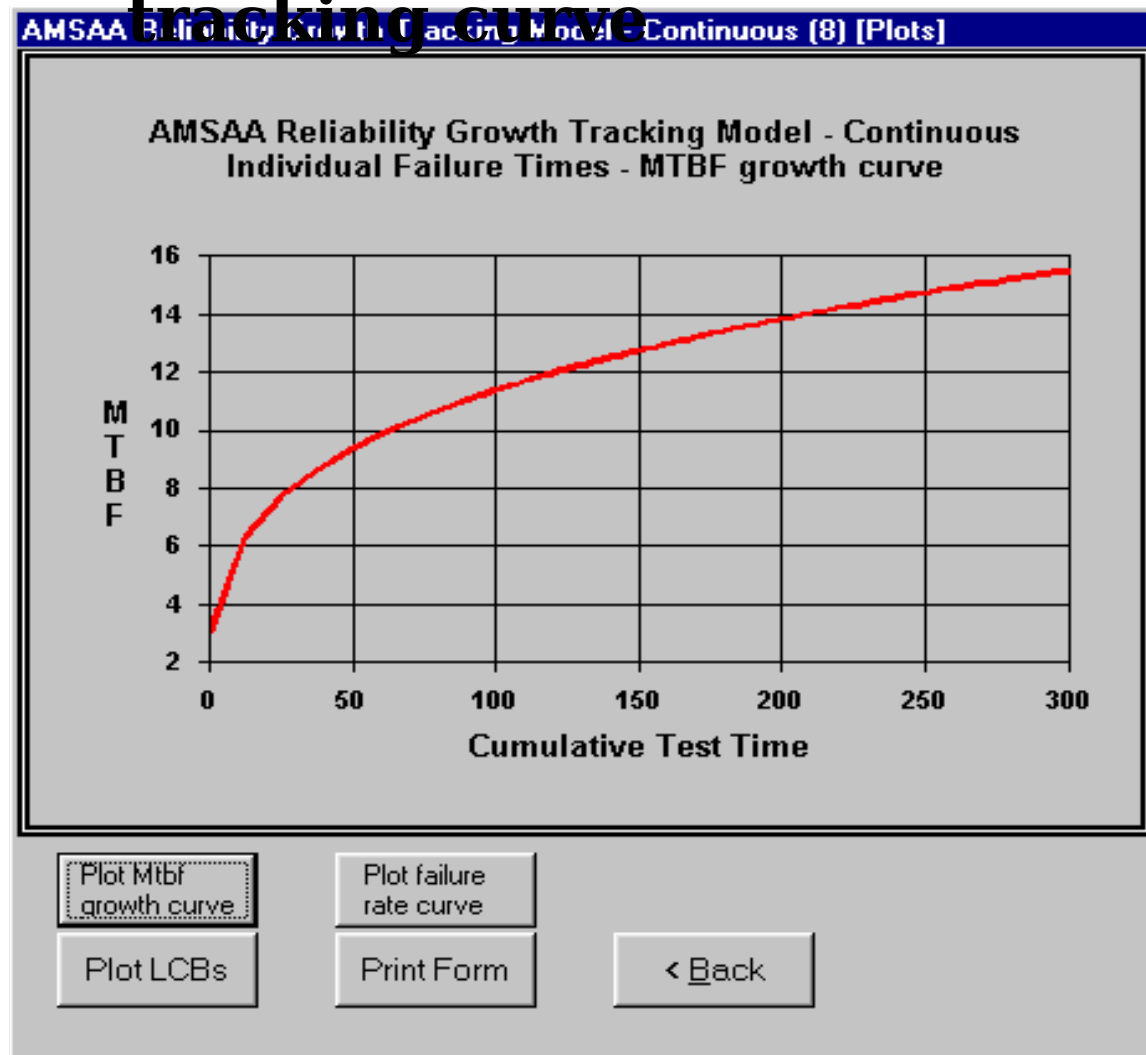
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[See Plots >](#)

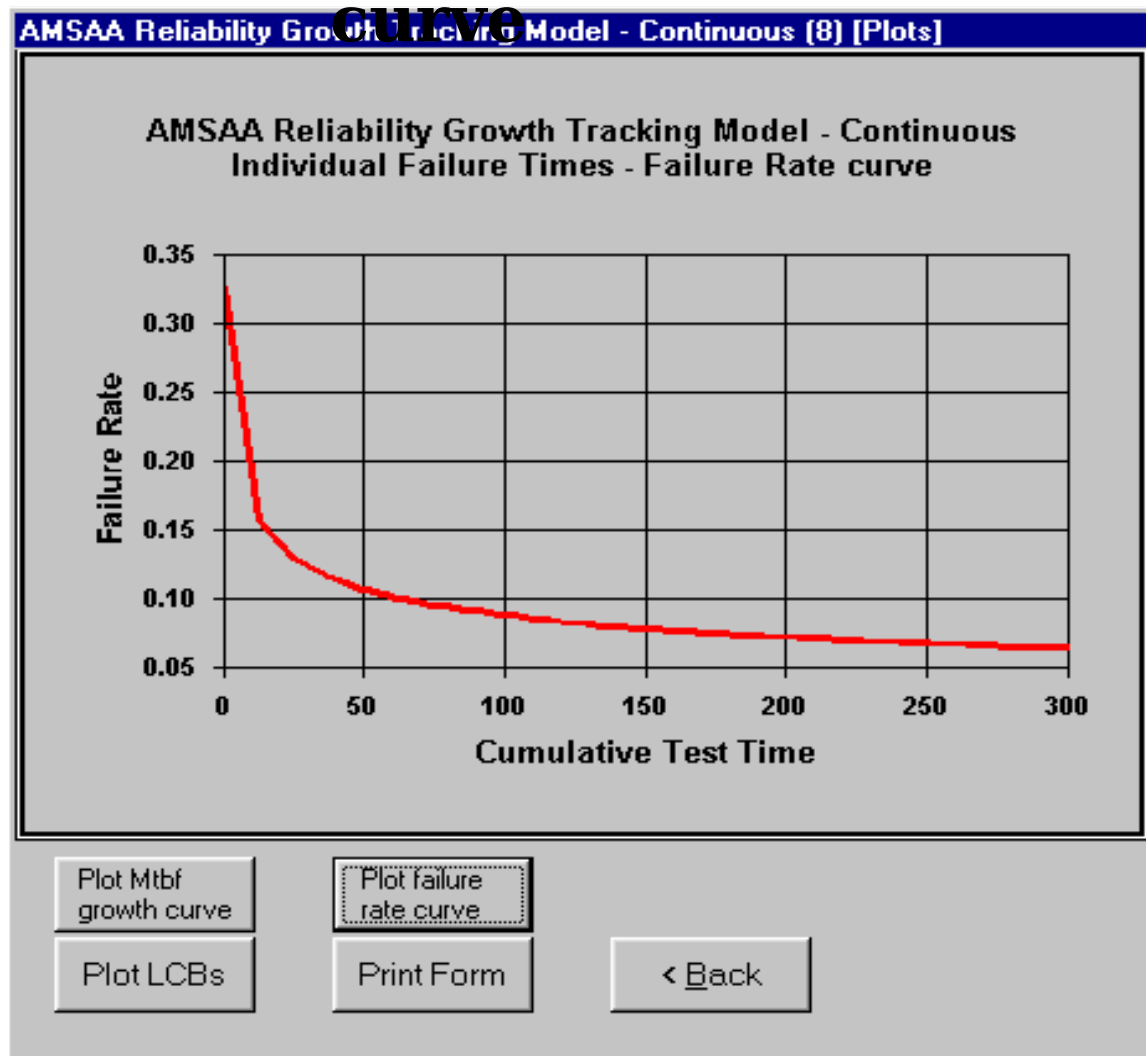
Reliability growth

tracking curve



Failure rate

curve



Plot of LCBs

